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Specificity in the Association of Anxiety, Depression, and Atopic Disorders in a Community Sample of Adolescents

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Abstract

The specificity of relationships between anxiety and depressive symptoms, with each of the major atopic disorders of asthma, allergic rhinitis (AR), and atopic dermatitis (AD) was systematically investigated within a single study sample. Participants included 367 adolescents who participated in a community, longitudinal study investigating risk factors for the development of psychiatric and physical health problems. Mental health symptoms were assessed at 7, 9, 11, and 13 years of age. Lifetime history of atopic disorders was assessed by parent report at age 13. Analysis of variance was used to investigate the specificity of the associations between anxiety and depression, and each of the atopic disorders. Results indicated that anxiety was associated with a lifetime history of atopic disorders as a group. The association was significantly strengthened when controlling for depression and externalizing psychiatric symptoms. Among atopic disorders, "pure" anxiety was associated with asthma and AR, and having both asthma and AR strengthened the association compared to having either disorder alone. The association of "pure" anxiety with asthma and AR is consistent with existing data suggesting a relationship between anxiety and respiratory disorders. Having both asthma and AR appeared to confer an additive "dose effect" on the strength of the association. The lack of an association with depression suggests that other factors may contribute to the differential expression of anxiety and depression with atopic disorders. Findings demonstrate the importance of assessing the impact of co-morbid psychiatric symptoms and atopic disorders within individual studies to determine the specificity of underlying relationships between these conditions.

Keywords

anxiety; depression; asthma; allergic rhinitis; atopic dermatitis

1. Introduction

Considerable research has focused on the association between internalizing psychiatric symptoms of anxiety and depression, and atopic disorders, a familial group of IgE-mediated allergies that includes asthma, allergic rhinitis, and atopic dermatitis (Slattery, 2005). Although findings collectively suggest an association between these psychiatric and allergic disorders, the specificity of the relationship remains unclear including whether the association exists broadly among groups, or conversely, only among specific disorder

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subtypes. Knowledge of this specificity, i.e. unique relationships between anxiety, depression and each of the atopic disorders, is important in providing a framework for subsequent investigations aimed at elucidating underlying mechanisms contributing to the etiopathogenesis of both types of disorders, and relatedly, the development of novel treatments targeting these specific pathways. A recent meta-analysis by Chida and colleagues (2008) highlights the psychosomatic relevance of this research, with findings demonstrating a bidirectional relationship between mental health symptoms and atopic disorders (Chida et al., 2008).

Existing studies largely focus on the relationship of anxiety and/or depression with each of the major atopic disorders. The association between asthma and internalizing psychiatric symptoms has been investigated most extensively to date. Both clinical and community studies provide substantive evidence of a link between asthma and anxiety disorders, and panic disorder in particular (Goodwin & Pine, 2002; Hasler et al., 2005), in both adults and children (Goodwin, 2003; Katon et al., 2004). An association between depression and asthma has also been reported (Morrison et al., 2002; Nejtek et al., 2001; Opolski & Wilson, 2005; Van Lieshout et al., 2009; Zielinski & Brown, 2003), although results are less consistent, especially when considering other disease-related factors such as asthma severity (Mancuso et al., 2008; Morrison et al., 2002) and co-occurring anxiety (Brown, 2000; Goodwin et al., 2003b, 2005; Goodwin & Pine, 2002; Katon et al., 2007b; Ortega et al., 2002). Findings collectively suggest that asthma may be more consistently associated with anxiety alone or in combination with depression, and that the relationship with depression may be influenced to a greater degree by asthma-related factors such as symptom severity and illness chronicity (Janson-Bjerklie et al., 1992; Mancuso et al., 2008; Opolski & Wilson, 2005).

There are fewer studies of a potential association between allergic rhinitis (AR), and anxiety or depression. Clinical investigations of adults and youth suggest that AR is associated with increased state and trait anxiety symptoms, as well as generalized anxiety disorder (Addolorato et al., 1999; Hart et al., 1995). Other studies report increased rates of depression in subjects with AR, although as with asthma, the relationship appears to be influenced by a number of variables including seasonality and AR-associated sleep loss (Kovacs et al., 2003; Marshall et al., 2002; Nathan, 2007). Results of community studies are also mixed (Cuffel et al., 1999; Goodwin, 2002).

Investigations of psychosomatic correlates of atopic dermatitis (AD) have predominately focused on the assessment of psychological and personality characteristics associated with AD, with results commonly reporting difficulties with anger, hostility, and insecurity (Ginsburg et al., 1993; White et al., 1990). Studies investigating the relationship between internalizing symptoms and AD are inconclusive, and suggest that AD may be associated with anxiety, depression, or both anxiety and depression (Annesi-Maesano et al., 2006; Hashiro & Okumura, 1994; Hashizume et al., 2005; Linnet & Jemec, 1999; Wittkowski et al., 2004). Symptoms of chronic, trait anxiety appear to occur more consistently, compared to those of state anxiety (Annesi-Maesano et al., 2006; Ginsburg et al., 1993; Linnet & Jemec, 1999).

In summary, existing investigations focus on the relationship between anxiety and/or depression and specific atopic disorders, within divergent study samples. This is the first study, to our knowledge, to systematically investigate the specificity of the relationships between both anxiety and depression, and each of the major atopic disorders, within a single study sample. Use of this study design permits the assessment of specific and independent associations among symptoms of anxiety and depression, and each of the unique atopic disorders, that might otherwise be masked by the co-occurrence of related conditions.

Results may shed new light on potential underlying mechanisms contributing to the frequent co-occurrence of these psychiatric and allergic states, and hence, open new windows to the development of targeted treatment interventions for these individuals.

Subjects are drawn from a community, longitudinal study of adolescents thus permitting assessment of trait-like mental health symptoms over time in relation to lifetime history of asthma, AR, and/or AD. The objectives of the present study are to 1) assess whether having any atopic disorder is associated with overall levels of anxiety vs. depressive symptoms and 2) assess the specificity of the relationship of each of the 3 atopic disorders (asthma, AR, and AD) with anxiety vs. depressive symptoms. We hypothesize that symptoms of anxiety will be more robustly associated with asthma, AR, and AD relative to symptoms of depression. Importantly, the investigation will also examine the potential impact of co-morbid psychiatric symptoms and atopic disorders on each of the possible associations, compared to relationships among "pure" anxiety, depression, asthma, AR, and AD.

2. Materials and methods

2.1. Subjects

Subjects included the 367 adolescents and mothers participating in a long-term longitudinal study (Wisconsin Study of Families and Work; WSFW) who had data on adolescent mental health problems and atopic disorders at the time of the Grade 7 assessment. The initial sample included 570 women recruited from pre-natal clinics. Eligibility requirements included being over age 18, in the second trimester of pregnancy, and because the original focus of the project was on issues of family and work, to be living with the father and either employed or homemakers (for details see (Hyde et al., 1995)). The study was approved by the Institutional Review Board of the University of Wisconsin-Madison. Informed consent was obtained from adults at each assessment; beginning at Grade 5, children provided informed assent.

The sample of 367 adolescents consisted of 175 boys and 192 girls; 11% represented ethnic minorities. At the time of recruitment (1990), 96% of the parents were married; family income ranged from less than $10,000 to over $200,000, (*Mdn* = $48,000). The 367 mothers ranged in age from 20 to 41 years; fathers ranged in age from 20 to 55 years. Of the mothers, 2% had less than a high school degree, 42% were high school graduates, and 56% were college graduates; of the fathers, 2% had less than a high school degree, 48% were high school graduates, and 50% were college graduates. The 367 families did not differ from the remainder of the original 570 families with respect to any of the above demographic characteristics with two minor exceptions: the participating mothers ($M = 29.7$, $SD = 4.3$) and fathers ($M = 31.7$, $SD = 5.2$) were 1 year older than non-participating mothers ($M = 28.8$, $SD = 4.4$) [$t(568) = -2.22$, $p = 0.027$] and fathers ($M = 30.5$, $SD = 4.7$) [$t(548) = -2.71$, $p = 0.007$]; and the participating fathers had a half-year more education ($M = 15.2$, $SD = 2.5$) than non-participating fathers ($M = 14.8$, $SD = 2.6$) [$t(548) = -1.98$, $p = 0.049$].

2.2. Measures

2.2.1. Children's lifetime history of atopic disorders—At Grade 7, mothers were asked about the adolescents' lifetime history of atopic disorders. For each of the three disorders (*Asthma*, *Allergic Rhinitis*, *Atopic Dermatitis*), mothers were asked whether or not (coded 1 vs. 0) their child ever had the condition. A summary measure of the three conditions was also constructed to define whether or not (coded 1 vs. 0) the adolescents had a *Lifetime History of Any Atopic Disorder*.

2.2.2. Adolescents' Mental Health Symptoms at Grades 1, 3, 5, 7—Mothers, teachers, and children were interviewed during the spring of Grades 1, 3, 5 and 7 about the child's mental health symptoms during the prior six months. Adults completed the Health and Behavior Questionnaire (Boyce et al., 2002; Essex et al., 2002); at Grade 1, children were administered the Berkeley Puppet Interview (Ablow et al., 1999; Measelle et al., 1998), which was modified to a flip-book format to be age-appropriate at the later assessments extending into adolescence. The mental health symptom items were derived primarily from the Ontario Child Health Study scales, well-established measures based on DSM-III criteria and with known reliability and validity (Boyle et al., 1993). The *Generalized Anxiety Symptoms* scale includes 11 items, e.g., Worries about doing better (all αs, across grades and reporters > 0.70, with exception of α = 0.61 for Grade 1 child report). The *Depression Symptoms* scale includes 12 items, e.g., Unhappy, sad, depressed (all αs > 0.77, with exception of α = 0.65 and 0.61 for Grade 1 mother and child report, respectively). The *Externalizing Symptoms* scale is the average of three subscales including oppositional defiant behaviors (*n* = 9 items, e.g., Defiant, talks back; all αs > 0.80, with exception of α = 0.42 and 0.63 for Grade 1 and 3 child report, respectively), conduct problems (*n* = 11 items, e.g., Destroys others' belongings; all αs > 0.74, with exception of α = 0.60 for Grade 1 child report), and inattention/impulsivity (*n* = 15 items, e.g., Cannot concentrate; all αs > 0.80). For each of the three symptom scales, the scores of the mothers, teachers, and adolescents were combined using Principal Components Analysis (PCA), where the first component represented what the three reports shared in common (see (Kraemer et al., 2003) for the original conceptualization of this approach to combining data from multiple informants based on the WSFW data). Across all assessments, the first component of each PCA accounted for over 50% of the variance and the factor loadings of each informant were above 0.50.

2.2.3. Additional measures—In addition to the major measures defined above, several other variables were considered in analyses, including *Child Sex* (0=male; 1=female), *Family Socioeconomic Status* (assessed with a PCA composite of parental education level and family annual income at the time of recruitment), and whether or not (coded 1 vs. 0) the adolescent had a lifetime history of any other of nine *Chronic Medical Conditions* (e.g., diabetes, bowel disease, kidney disease, thyroid problems).

3. Results

3.1 Descriptive statistics

Table 1 presents descriptive statistics for the three atopic disorders and the psychiatric symptoms, and differences by child gender and family socioeconomic status (SES). Of the three atopic disorders, adolescents were most likely to have a lifetime history of allergic rhinitis, followed by asthma and atopic dermatitis, with prevalence rates similar to an epidemiological study of comparable aged youth (Shamssain & Shamsian, 2001). When considered together, approximately half of the adolescents had a lifetime history of at least one of the three atopic disorders: 109 adolescents had only one atopic disorder (asthma = 27, AR = 66, AD = 16); 45 had two atopic disorders (asthma + AR = 29, asthma + AD = 9, AR + AD = 7); and 16 had a lifetime history of all three atopic disorders.

Chi-square, t-tests, and correlational analyses were used to investigate differences in lifetime atopic disorders and mental health symptoms by child gender and family SES. Compared with girls, boys were significantly more likely to have a lifetime history of any atopic disorder ($\chi^2 = 6.26$, $df = 1$, $p = 0.008$), and they evidenced lower levels of anxiety symptoms [$t(365) = -2.50$, $p = 0.013$] and higher levels of externalizing symptoms [$t(365) = 5.34$, $p < 0.001$]. There were no SES differences in lifetime history of any atopic disorder [$t(365) =$

−0.12, $p = 0.903$]. However, adolescents born into lower SES families evidenced higher levels of anxiety, depression, and externalizing symptoms. Given these associations, child sex and family SES were included as controls in all analyses.

3.2. Specificity of association of lifetime history of any atopic disorder with anxiety vs. depression symptoms from Grade 1 to Grade 7

Analysis of variance (ANOVA) was used to address the first major research question: whether the association of lifetime history of any atopic disorder was specific to overall levels of generalized anxiety symptoms vs. depressive symptoms from Grade 1 to Grade 7. Two initial ANOVAs were conducted, one with generalized anxiety symptoms as the dependent variable and one with depression symptoms as the dependent variable (Table 2, Model 1). The results showed that a lifetime history of any atopic disorder was associated with significantly higher overall levels of generalized anxiety symptoms, but there was no significant association with depression symptoms.

Because we found, as expected, substantial co-occurrence of childhood anxiety and depression symptoms ($r = 0.75$; $p < 0.001$), as well as each of these with externalizing symptoms (anxiety, $r = 0.48$; $p < 0.001$; depression, $r = 0.60$; $p < 0.001$), a second set of ANOVAS was conducted to control for co-occurring symptoms (Table 2, Models 2 – 4). Results showed that the association of lifetime history of any atopic disorder with generalized anxiety symptoms was strengthened (i.e., F values increased, with stronger significance levels) when depression symptoms (Model 2), externalizing symptoms (Model 3), or both types of symptoms (Model 4) were controlled. However, the association of lifetime history of any atopic disorder with depression symptoms remained non-significant when anxiety and externalizing symptoms were controlled. Together, these results suggest that a lifetime history of any atopic disorder is associated more specifically with “pure” generalized anxiety symptoms rather than those co-occurring with either depression symptoms or, as we have previously shown (Infante et al., 2007), with externalizing symptoms. Thus, for the remaining analyses, externalizing symptoms and either depression (for analyses with anxiety as the dependent variable) or anxiety (for analyses with depression as the dependent variable) symptoms were controlled.

3.3. Specificity of type of atopic disorder with anxiety vs. depression symptoms

The second major research question focused on whether the association of atopic disorders with anxiety/depression symptoms is specific to any of the three atopic disorders considered. Two ANOVAS were conducted, one for anxiety symptoms and one for depression symptoms, including the three dichotomous variables defining a lifetime history of asthma, allergic rhinitis, and atopic dermatitis (Table 3). As expected based on the above results, there were no significant associations of depression symptoms with a lifetime history of asthma, allergic rhinitis, or atopic dermatitis. However, for anxiety symptoms, significant associations were found for asthma and allergic rhinitis, but not atopic dermatitis. These results, illustrated in Figures 1 and 2, suggest that there is specificity in the association of respiratory atopic disorders with generalized anxiety symptoms.

3.4. Is there a dose effect?

Because we found associations between generalized anxiety symptoms and both asthma and allergic rhinitis, we also investigated whether the association was stronger for adolescents with lifetime histories of both respiratory atopic disorders compared to those with only asthma or allergic rhinitis. To address this question, the above ANOVA for generalized anxiety was rerun with the two variables defining asthma and allergic rhinitis collapsed into a single variable defining adolescents with lifetime histories of neither (0), only one (1), or both (2) of these atopic disorders. The results, shown in Table 4 and illustrated in Figure 3,

clarify that there is a dose effect. Further, a comparison of adolescents with no lifetime history of respiratory atopic disorders with the other two groups shows that adolescents with a lifetime history of *either* asthma or allergic rhinitis evidenced marginally ($p = 0.085$) higher levels of generalized anxiety symptoms, whereas adolescents with a lifetime history of *both* atopic disorders evidenced significantly ($p < 0.001$) higher levels of generalized anxiety symptoms from Grade 1 to Grade 7.

Finally, to ensure that these associations were specific to atopic disorders, we included a variable distinguishing adolescents with and without a lifetime history of other chronic medical conditions. Results showed that the dose effect on generalized anxiety symptoms of number of respiratory atopic disorders remained significant [$F(2,357) = 7.86$, $p < 0.001$], and there was no additional effect of other chronic medical conditions [$F(1,357) = 1.42$, $p = 0.235$].

4. Discussion

This is the first study, to our knowledge, to address the central question of specificity of associations among symptoms of anxiety and depression, with the three major atopic disorders of asthma, AR, and AD using a single sample design. Moreover, analyses addressed the potential influences of co-morbid psychiatric symptoms and atopic conditions on these associations.

Results showed that symptoms of anxiety, but not depression, were broadly associated with a lifetime history of atopic disorders as a group. Moreover, a more robust association was found between atopic disorders and symptoms of “pure” anxiety vs. anxiety with co-morbid depression and/or externalizing symptoms. These findings are similar to those reported by our group in a previous clinical study of children and adolescents (Infante et al., 2007) in which only pure internalizing disorders were associated with atopic disorders compared to youth with co-morbid internalizing and externalizing disorders. Together, these findings suggest that externalizing psychiatric symptoms may partially obscure the identification of underlying associations of internalizing symptoms with atopic disorders, and importantly, that within internalizing symptoms, depression symptoms may partially obscure the more robust association of anxiety with atopic disorders. Further, among atopic disorders, pure anxiety symptoms were associated with asthma and AR, and not with AD, thus supporting existing studies suggesting a link between respiratory disorders and anxiety (Brenes, 2003; Goodwin & Buka, 2008; Nardi et al., 2009). Finally, the study found that having a lifetime history of both asthma and AR appeared to confer an additive “dose effect” in the association with pure anxiety. Depressive symptoms were not associated with any of the three atopic disorders in this community sample.

Results of our study agree with existing investigations reporting a more consistent association of asthma and AR with anxiety than depression (Brown, 2000; Goodwin et al., 2003b; Katon et al., 2007a; Ortega et al., 2002). Although asthma and AR are clinically distinct, contemporary research suggests that these disorders are more accurately conceptualized and treated as inflammation of one common airway (Nayak, 2003). If so, findings are further aligned with a well established body of evidence linking anxiety with respiratory abnormalities in children and adults (Nardi et al., 2009; Pine et al., 1998; Ryu et al., 2010). Our findings differ from existing studies reporting an association between depression, and asthma or AR, and suggest that other factors may contribute to this relationship, such as respiratory disease severity or chronicity (Janson-Bjerklie et al., 1992; Mancuso et al., 2008; Opolski & Wilson, 2005). Further, the lack of an association between anxiety or depression with AD as reported in other investigations may reflect other shared

disease mechanisms not assessed in this study such as AD quality of life or AD disease severity (Hashiro & Okumura, 1997; Linnet & Jemec, 1999; Wittkowski et al., 2004).

Potential mechanisms underlying the association between anxiety, and asthma and AR remain unclear. Prevailing theories suggest that the association may reflect activation of an innate, fear-based neural network to perceived or experienced breathlessness or dyspnea (Ley, 1989; Nardi et al., 2009), or alternatively, activation of a suffocation alarm system due to alterations in central mechanisms of carbon dioxide sensitivity (Klein, 1993; Martinez et al., 2001). Findings of a more robust association of anxiety in adolescents with a lifetime history of both asthma and AR may reflect the effects of repeated respiratory inflammation and recurrent sensitization to conditioned dyspneic fear. Alternatively, having both asthma and AR may reflect increased respiratory disease severity contributing to an increased likelihood of co-occurring anxiety as, suggested by others. (Goodwin et al., 2003a; McQuaid et al., 2001; Wamboldt et al., 1998).

The association between anxiety and respiratory atopic disorders might also reflect broader issues related to a sense of well being as individuals attempt to adapt to ongoing illnesses. Although speculative, repeated experiences of respiratory distress might be expected to impact individuals differently compared to recurring AD, that is, repeated sensitization to experiences of breathlessness may sustain an innate and more robust link between respiratory distress and anxiety. Conversely, exacerbations of AD are commonly characterized by the subjective distress of intense pruritus and sleep loss (Bender et al., 2008) but do not typically pose a physiological threat to survival and homeostasis. Thus, co-occurrence of AD with depression and anxiety as reported in other studies may reflect other shared disease mechanisms such as quality of life (Linnet & Jemec, 1999; Wittkowski et al., 2004), disease severity (Hashiro & Okumura, 1997; Wittkowski et al., 2004), or other factors such as activation of pro-inflammatory cytokines through separate, non-atopic immune pathways (Anisman & Merali, 2003; Raison et al., 2006). Moreover, consistent with models of an “atopic march”, AD is more prevalent during infancy, and commonly resolves, compared to the later development of asthma and AR during childhood and adolescence (Cantani, 1999). Mental health symptoms in this study were assessed during late childhood and adolescence, and therefore, may not capture the impact of co-existing AD experienced during infancy/early childhood.

Our findings might also be explained by dysregulation of key neurobiological components of the stress response system. In particular, alterations of the hypothalamic-pituitary-adrenal (HPA) axis have been reported in children and adults with atopic disorders (Buske-Kirschbaum et al., 2002a, 2003; Van Lieshout et al., 2009), as well as anxiety and depression (Abelson et al., 2007; Van Lieshout et al., 2009; Young et al., 2004). HPA function is intimately linked to homeostatic regulation of the immune system, and under optimal function, constrains inflammatory responses activated by stress (Eskandari & Sternberg, 2002). In the case of asthma and AR, abnormalities in this system may result in unrestrained airway inflammation and activation of shared respiratory pathways. Support for this model is derived from a number of studies reporting an association between stressful life events and increased risk of asthma, allergies, anxiety, and depression (Arndt et al., 2008; Buske-Kirschbaum et al., 2002b; Kiecolt-Glaser et al., 2009; Liu et al., 2002; Roberts et al., 2009; Sandberg et al., 2000; Scott et al., 2008; Turyk et al., 2008; Wright, 2007).

Limitations of the present study include assessment of a single domain of anxiety symptoms (generalized anxiety), as patterns of association may differ for other types of anxiety such as panic disorder. The prevalence of panic disorder among children and young adolescents, however, is low, thereby decreasing the probability that our findings are affected by this underlying anxiety disorder, and further strengthening the likelihood that generalized

anxiety symptoms, asthma, and AR may share common mechanisms of disease (Beesdo et al., 2009). Lifetime occurrence of atopic disorders is based upon parental report. While this method is commonly used to assess atopic disorders within clinical and epidemiologic studies (Goodwin, 2003), future investigations should attempt to integrate objective measures of atopic disorders such as standardized clinical exams (Oranje et al., 1997) and laboratory measures of atopy, e.g. skin testing (Timonen et al., 2002). Similarly, standardized measures of anxiety, depression, and co-occurring psychiatric symptoms should also be used, ideally integrating multi-informant report of symptoms as was done in this study to strengthen the validity of symptom assessment. Finally, although our study did control for potential confounding effects of co-morbidity among atopic disorder subtypes, anxiety, depression, and externalizing psychiatric symptoms, other chronic medical conditions, SES, and gender, we did not assess other potential variables such as family relationships, smoking, or family history of psychiatric or atopic disorders as investigated by others (Bender et al., 2000; Goodwin et al., 2004; Slattery et al., 2002).

In summary, this study significantly contributes to existing research by demonstrating the specificity of associations when substantially correlated measures of anxiety and depression are considered together with multiple, often co-morbid, atopic disorders. Results indicate that symptoms of anxiety were specifically associated with a lifetime history of asthma and AR, and that this association was partially obscured by co-existing AD, and depressive and externalizing symptoms. Previous studies may not fully reflect the true nature of the underlying relationships if effects of other co-morbid psychiatric symptoms and atopic disorders are not assessed. Clarification of these relationships is essential to the identification of potential underlying shared mechanisms, and the subsequent development of treatments targeting these specific pathways. Given the limitations of the present study, replication of the findings is important. Nevertheless, identification of these specific psychiatric – allergic disorder associations through systematic assessment of co-existing conditions provides an important basis for future studies investigating factors underlying these relationships.

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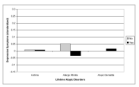

Fig. 1.
Specificity of lifetime atopic disorders and overall levels of depression symptoms from Grade 1 to 7.

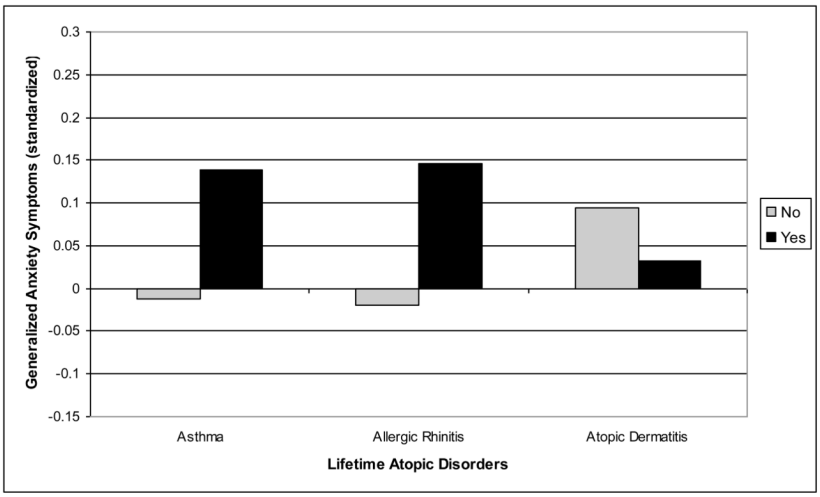

Fig. 2.
Specificity of lifetime atopic disorders and overall levels of generalized anxiety symptoms from Grade 1 to 7.

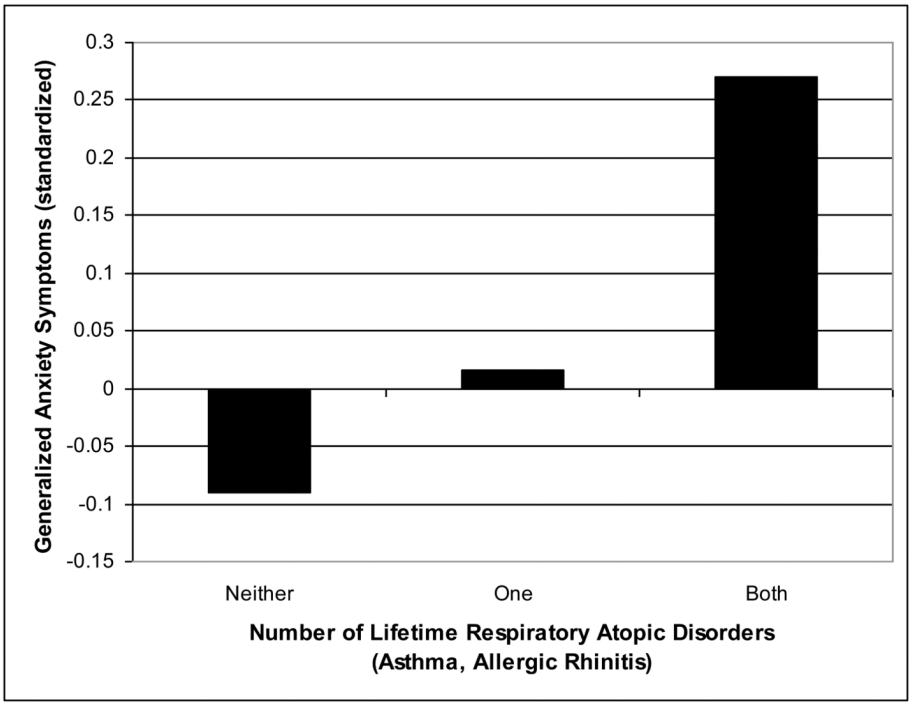

Fig. 3.
Dose effect of lifetime respiratory atopic disorders and overall levels of generalized anxiety symptoms from Grade 1 to 7.

Table 1

Descriptive statistics for psychiatric symptoms and the three atopic disorders.

N (%)	**Anxiety Symptoms[a] *M* (*SD*)**	**Depression Symptoms[a] *M* (*SD*)**	**Externalizing Symptoms[a] *M* (*SD*)**	**No Lifetime any Atopic Disorder *N* (%)**	**Lifetime any Atopic Disorder *N* (%)**	**Lifetime Asthma[b] *N* (%)**	**Lifetime Allergic Rhinitis[b] *N* (%)**	**Lifetime Atopic Dermititis[b] *N* (%)**
Full Sample 367 (100.0)	.013 (.803)	.019 (.845)	.019 (.915)	197 (53.7)	170 (46.3)	81 (22.1)	118 (32.1)	48 (13.2)
Female 192 (52.3)	.112 (.801)	.063 (.828)	−.216 (.775)	115 (59.9)	77 (40.1)	42 (21.9)	55 (28.6)	19 (9.9)
Male 175 (47.7)	−.096 (.793)	−.029 (.864)	.276 (.988)	82 (46.9)	93 (53.1)	39 (22.3)	63 (36.0)	29 (16.6)
M (*SD*)	Anxiety Symptoms *r*	Depression Symptoms *r*	Externalizing Symptoms *r*	No Lifetime any Atopic Disorder *M* (*SD*)	Lifetime any Atopic Disorder *M* (*SD*)	Lifetime Asthma[a] *M* (*SD*)	Lifetime Allergic Rhinitis[a] *M* (*SD*)	Lifetime Atopic Dermititis[a] *M* (*SD*)
SES[a] .069 (.978)	−.268***	−.278***	−.300***	.063 (.976)	.076 (.985)	.167 (.984)	.008 (.965)	.049 (.930)

[a] Standardized score

[b] Counts for each of these atopic disorders are not mutually exclusive

*** $p<0.001$

Table 2

Results of ANOVA associations of lifetime atopic disorders (D/O) with generalized anxiety and depression symptoms.

	Model 1[a]			Model 2[b]			Model 3[c]			Model 4[d]		
Symptoms (dependent variable)	**No Atopic D/O *M* (*SE*)**	**Atopic D/O *M* (*SE*)**	***F* (1,363)**	**No Atopic D/O *M* (*SE*)**	**Atopic D/O *M* (*SE*)**	***F* (1,362)**	**No Atopic D/O *M* (*SE*)**	**Atopic D/O *M* (*SE*)**	***F* (1,362)**	**No Atopic D/O *M* (*SE*)**	**Atopic D/O *M* (*SE*)**	***F* (1,361)**
Anxiety	−0.080 (.055)	.121 (.059)	6.24*	−.066 (.037)	.104 (.040)	9.46**	−.091 (.047)	.133 (.051)	10.29**	−.069 (.037)	.107 (.040)	10.24**
Depression	−.003 (.058)	.043 (.063)	0.29	.070 (.040)	−.041 (.043)	3.47	−.016 (.046)	.059 (.050)	1.22	.046 (.037)	−.013 (.039)	1.20

[a] Adjusted for child sex and SES

[b] Adjusted for child sex, SES, and either depression or anxiety symptoms

[c] Adjusted for child sex, SES, and externalizing symptoms

[d] Adjusted for child sex, SES, either depression or anxiety symptoms, and externalizing symptoms

* $p<0.05$;

** $p<0.01$

Table 3

Results of ANOVA associations for each of the atopic disorders (lifetime) with generalized anxiety and depression symptoms.[a]

	Asthma			Allergic Rhinitis			Atopic Dermatitis		
Symptoms (dependent variable)	**No *M* (*SE*)**	**Yes *M* (*SE*)**	***F* (1,357)**	**No *M* (*SE*)**	**Yes *M* (*SE*)**	***F* (1,357)**	**No *M* (*SE*)**	**Yes *M* (*SE*)**	***F* (1,357)**
Anxiety	−.013 (.049)	.139 (.061)	4.53*	−.020 (0.49)	.146 (.054)	7.49**	.094 (.038)	.032 (.075)	0.53
Depression	.009 (.048)	.007 (.060)	0.001	.051 (.048)	−.035 (.054)	2.02	<.001 (.037)	0.16 (.074)	0.04

[a] Adjusting for child sex, SES, externalizing symptoms, and either depression or anxiety symptoms

* $p<0.05$;

** $p<0.01$

Table 4

Results of ANOVA associations for asthma and/or allergic rhinitis with generalized anxiety symptoms.[a]

Symptoms (dependent variable)	Neither Asthma nor Allergic Rhinitis *M* (*SE*)	Either Asthma or Allergic Rhinitis *M* (*SE*)	Both Asthma and Allergic Rhinitis *M* (*SE*)	*F* (2,358)
Anxiety	−.090 (.050)	.016 (.058)	.270 (.079)	8.35***

[a] Adjusting for child sex, SES, depression symptoms, externalizing symptoms, and atopic dermatitis

*** $p<0.001$